Calculating Curve Numbers Using GIS

The Hydrologic Studies Unit (HSU) of Michigan's Department of Environmental Quality (MDEQ) has developed a method to compute curve numbers from GIS land use and soils information. The instructions assume that you have an ArcView project open with a delineated watershed theme, land use theme, and a soils theme.

The basic technique is to assign a number less than 100 to each land use category and a number that is a multiple of 100 to each soil category. The two numbers are summed. Curve numbers are associated with each summed number. A composite curve number is then calculated using area-weighted averaging. Specific instructions are as follows.

In these instructions, italics are used to highlight ArcView menu items and variables. Bold is used to highlight Field names in tables.

Copy text files	1. Many text files are included with these instructions. Copy Soils-cn.txt, Landuse-cn.dbf, and Rcn-cn3.txt to your computer. Text files that correlate NRCS soil codes to hydrogroup designations for each county are named *county*sls.txt. Copy the files for the applicable counties to your computer. TIP: The soils information is derived from the NRCS National Map Unit Interpretation Records (MUIR) database, http://soildatamart.nrcs.usda.gov/. Soil hydrogroup information for other states can be obtained there.
Name subbasins	2. If you want to compute curve numbers for multiple subbasins at once, give each subbasin a unique name in the watershed theme.
Start Geoprocessing	3. Go to *File*, *Extensions* and check *Geoprocessing*.
Clip soil (input) theme with subbasin (overlay) theme	4. Go to *View*, *Geoprocessing Wizard*. Select *Clip one theme based on another*. Define the soil theme as the input theme and the watershed theme as the overlay theme. Specify the location of the output file and click *Finish*. TIP: If the watershed theme has more subbasins than you are interested in, highlight the subbasins of interest with the *Select Feature* tool  . Make sure that *Use Selected Features Only* is checked underneath the watershed theme name.
Open soil table	5. Highlight the soil theme in your ArcView project. Open the table for the soil theme using the *Open Theme Table* icon  . Close or minimize the View window, leaving the soils table open.

Join Hydrogroup table	6. Click on the *Tables* icon  in the project window. Add the applicable *county*sls.txt table to your project. Open the table. Highlight the ID field to make it active. Highlight the Musym field in the soil table. Click the *Join* icon  to add the first table to the second.
Check for blanks	7. Check for and delete records where the Hydgrp field is blank. Most of the blank fields should be blank because the soil is defined as a pit. If there are extensive gaps in the soil coverage, these can be corrected manually with a NRCS soil survey book. TIP: To select multiple records manually, hold the SHFT key down while selecting. To use query builder to search for blank records, the format is [*fieldname*].IsNull.
Intersect soil (input) and subbasin (overlay) themes	8. If you are calculating curve numbers for multiple subbasins, Go to *View*, *Geoprocessing Wizard*. Select *Intersect two themes*. Define the clipped soil theme as the input theme and the watershed theme as the overlay theme. Specify the location of the output file and click *Finish*.
Clip land use (input) theme with subbasin (overlay) theme	9. Go to *View*, *Geoprocessing Wizard*. Select *Clip one theme based on another*. Define the land use theme as the input theme and the watershed theme as the overlay theme. Specify the location of the output file and click *Finish*.
Intersect land use (input) and soil (overlay) theme	10. Go to *View*, *Geoprocessing Wizard*. Select *Intersect two themes*. Define the clipped land use theme as the input theme and the intersected soil and watershed theme as the overlay theme. Specify the location of the output file and click *Finish*.
Open intersected soil and land use table	11. Open the table for the intersected soil and land use theme using the *Open Theme Table* icon  . Close or minimize the View window, leaving the table open.
Add Soils-cn, Landuse-cn, and Rcn-cn text tables	12. Click on the *Tables* icon  in the project window. Add the three tables Soils-cn.txt, Landuse-cn.dbf, and Rcn-cn.txt, Figures 1, 2, and 3 respectively, to your project. Open the landuse-cn.dbf table. Highlight the lgds_text field to make it active.
Join landuse-cn to intersected soil and land use table	13. Highlight the level3 field in the intersected soil and land use table. Click the *Join* icon  to add the first table to the second. If lgds_text doesn't join to the intersected soil and land use table, use lgds_strng .

Join Soils-cn to intersected soil and land use table	14. Open the Soils-cn table. Highlight the Soil-class field to make it active. Highlight the Hydgrp field in the intersected soil and land use table. Click the *Join* icon  to add the first table to the second.
Add CN-code field	15. Make sure the intersected soil and land use table is the active table. Go to *Table*, *Start Editing*. Go to *Edit*, *Add Field*… Specify the new field as *Name: CN-code*, *Type: Number*, *Length: 8*, *Decimal Places:0*.
Calculate Cn-code	16. Make sure CN-code is the active field. Click the *Calculate* button  . Set *CN-code* equal to [Class] + [Value]. TIP: Double click on [Class], then +, and then [Value], rather than typing the expression [Class] + [Value].
Check for blanks	17. Check for and delete records where the CN-code field is blank. If there are significant gaps, determine if there is a coverage or procedural problem and, if so, correct the problem. Otherwise, delete the records. If there is a code in the level3 field that is not listed in the Landuse-cn.txt table, please let us know at 517-335-3176 or sorrell@michigan.gov.
Join Rcn-cn to intersected soil and land use table	18. Open the Rcn-cn table. Highlight the compcode field to make it active. Highlight the CN-code field in the intersected soil and land use table. Click the *Join* icon  to add the first table to the second. This step associates curve numbers with the number representing the land use and soil. Where the soil has a dual classification, B/D for example, the soil type is specified as D for natural land uses or the alternate classification (A, B, or C) for developed land uses. The Soil field in the joined Rcn-cn table lets you display the resolved soil type.
Add CN ratio fields	19. Add four more fields to the intersected soil and land use table – CN1/8ratio, CN1/4ratio, CN1/3ratio, and CN1/2ratio. If you know which residential densities you want to compute, you only need to add those fields. The fields should specified as *Type: Number*, *Length: 16*, *Decimal Places:0*.

Refresh Area	20. Highlight the first Area field, click the *Calculate* button  and enter *[Shape].returnarea* to refresh the areas for each polygon. TIP: The values in the Area field should be in square meters. To convert square meters to acres, multiply by 0.0002471. To convert square meters to square miles, multiply by 0.0000003861.
Calculate CN ratios	21. Make the CN1/8ratio field active. Click the *Calculate* button  and enter *[Area]*1/8acre*. Repeat for the other residential densities.
Highlight column to summarize	22. If you are calculating curve numbers for multiple subbasins, highlight the field that has the names of the subbasins. If you are calculating a single curve number, highlight a field where all of the entries are identical, such as the Code field.
Summarize	23. Click the *Summarize* button  to create a new table. Specify where the table will be saved. Change *Field:* to the first *Area* and *Summarize by:* to *Sum*. Click *Add*. Change *Field:* to *CN1/8ratio* and *Summarize by:* to *Sum* and click *Add*. Repeat for the other CNratio fields. Then click OK. A new table will be generated.
Add CN fields	24. Make sure the new table is the active table. Go to *Table*, *Start Editing*. Go to *Edit*, *Add Field…* Specify the new field as *Name: CN1/8*, *Type: Number*, *Length: 8*, *Decimal Places:1*. Repeat for the other residential densities.
Calcualtes CNs	25. Make the CN1/8 field active. Click the *Calculate* button  and enter *[Sum_CN1/8ratio]/[Sum_Area]*.

Table 1: Soils-cn.txt

Soil-class	Value
A	100
A/B	200
A/C	300
A/D	400
B	500
B/C	600
B/D	700
C	800
C/D	900
D	1000
TNT	800
URB	1000

Table 2: Landuse-cn.dbf

lgds_text	Class	Code	Description	LGDS_STRNG
1	1	1	Urban	1
11	1	1	Residential	11
111	1	1	Multi-Family: High Rise	111
112	1	1	Multi-Family: Low Rise	112
113	1	1	Single Family	113
1133	1	1	Single Family something	1133
115	1	1	Mobile Home Park	115
12	2	1	Commercial	12
121	2	1	Primary/Central Business District	121
122	2	1	Shopping Center/Mall	122
124	2	1	Secondary/Neighborhood Business	124
126	2	1	Institutial	126
13	3	1	Industrial	13
138	3	1	Industrial Park	138
14	4	1	Transportation	14
141	4	1	Air Transportation	141
142	4	1	Rail Transportation	142
143	4	1	Water Transportation	143
144	4	1	Road Transportation	144
145	4	1	Communication	145
146	4	1	Utilities	146
17	5	1	Extractive	17
171	5	1	Open Pit	171
172	5	1	Underground	172
173	5	1	Wells	173
1714	5	1	??	1714
19	6	1	Open Land	19
193	6	1	Outdoor Recreation	193
194	6	1	Cemeteries	194
2	7	1	Agriculture]	2

lgds_text	Class	Code	Description	LGDS_STRNG
21	7	1	Cropland	21
22	8	1	Orchards	22
23	9	1	Confined Feeding	23
24	9	1	Permanent Pasture	24
29	7	1	Other	29
3	10	1	Open Field	3
31	10	1	Herbaceous	31
32	10	1	Shrub	32
4	11	1	Woodland	4
41	11	1	Deciduous	41
411	11	1	Northern Hardwood	411
412	11	1	Central Hardwood	412
413	11	1	Aspen/White Birch	413
414	11	1	Lowland Hardwood	414
42	11	1	Coniferous	42
421	11	1	Pine	421
422	11	1	Other Upland Conifer	422
423	11	1	Lowland Conifer	423
429	11	1	Christmas Tree Plantation	429
43	11	1	Mixed Conifer-Broadleaf Forest	43
5	12	1	Water	5
51	12	1	Stream	51
52	12	1	Lake	52
53	12	1	Reservoir	53
54	12	1	Great Lakes	54
6	13	1	Wetland	6
61	13	1	Forested Wetland	61
611	13	1	Wooded Wetland	611
612	13	1	Shrub/Scrub	612
614	13	1	?? Wetland	614
62	13	1	Nonforested Wetland	62
621	13	1	Aquatic Bed Wetland	621
622	13	1	Emergent Wetland	622
623	13	1	Flats Wetland	623
624	13	1	Submerged Aquatics	624
7	14	1	Barren	7
72	14	1	Beach	72
73	14	1	Sand Dune	73
74	15	1	Exposed Rock	74
999	16	1	UNIDENTIFIED	999

Table 3: Rcn-cn3.txt

Ccode	1/8acre	1/4acre	1/3acre	1/2acre	Land use description	Soil"
101	77	61	57	54	Residential A	A
102	89	89	89	89	Commercial A	A
103	81	81	81	81	Industrial A	A
104	98	98	98	98	Road, Utilities A	A
105	0	0	0	0	Open Pit A	A
106	39	39	39	39	Outdoor Recreation A	A
107	65	65	65	65	Cropland A	A
108	45	45	45	45	Orchards A	A
109	49	49	49	49	Permanent Pasture A	A
110	30	30	30	30	Shrubland A	A
111	45	45	45	45	Central Hardwood, Pine A	A
112	100	100	100	100	Lake, Pond A	A
113	78	78	78	78	Wetland A	A
114	63	63	63	63	Sand Dune A	A
115	98	98	98	98	paved A	A
201	77	61	57	54	Residential A/B	A
202	89	89	89	89	Commercial A/B	A
203	81	81	81	81	Industrial A/B	A
204	98	98	98	98	Road, Utilities A/B	A
205	0	0	0	0	Open Pit A/B	A
206	39	39	39	39	Outdoor Recreation A/B	A
207	65	65	65	65	Cropland A/B	A
208	45	45	45	45	Orchards A/B	A
209	49	49	49	49	Permanent Pasture A/B	A
210	58	58	58	58	Shrubland A/B	B
211	60	60	60	60	Central Hardwood, Pine A/B	B
212	100	100	100	100	Lake, Pond A/B	B
213	78	78	78	78	Wetland A/B	B
214	77	77	77	77	Sand Dune A/B	B
215	98	98	98	98	paved A/B	A
301	77	61	57	54	Residential A/C	A
302	89	89	89	89	Commercial A/C	A
303	81	81	81	81	Industrial A/C	A
304	98	98	98	98	Road, Utilities A/C	A
305	0	0	0	0	Open Pit A/C	A
306	39	39	39	39	Outdoor Recreation A/C	A
307	65	65	65	65	Cropland A/C	A
308	45	45	45	45	Orchards A/C	A
309	49	49	49	49	Permanent Pasture A/C	A
310	71	71	71	71	Shrubland A/C	C
311	73	73	73	73	Central Hardwood, Pine A/C	C
312	100	100	100	100	Lake, Pond A/C	C
313	78	78	78	78	Wetland A/C	C
314	85	85	85	85	Sand Dune A/C	C
315	98	98	98	98	paved A/C	A
401	77	61	57	54	Residential A/D	A

Ccode	1/8acre	1/4acre	1/3acre	1/2acre	Land use description	Soil"
402	89	89	89	89	Commercial A/D	A
403	81	81	81	81	Industrial A/D	A
404	98	98	98	98	Road, Utilities A/D	A
405	0	0	0	0	Open Pit A/D	A
406	39	39	39	39	Outdoor Recreation A/D	A
407	65	65	65	65	Cropland A/D	A
408	45	45	45	45	Orchards A/D	A
409	49	49	49	49	Permanent Pasture A/D	A
410	78	78	78	78	Shrubland A/D	D
411	79	79	79	79	Central Hardwood A/D	D
412	100	100	100	100	Lake, Pond A/D	D
413	78	78	78	78	Wetland A/D	D
414	88	88	88	88	Sand Dune A/D	D
415	98	98	98	98	paved A/D	A
501	85	75	72	71	Residential B	B
502	92	92	92	92	Commercial B	B
503	88	88	88	88	Industrial B	B
504	98	98	98	98	Road, Utilities B	B
505	0	0	0	0	Open Pit B	B
506	61	61	61	61	Outdoor Recreation B	B
507	77	77	77	77	Cropland B	B
508	66	66	66	66	Orchards B	B
509	69	69	69	69	Permanent Pasture B	B
510	58	58	58	58	Shrubland B	B
511	60	60	60	60	Central Hardwood, Pine B	B
512	100	100	100	100	Lake, Pond B	B
513	78	78	78	78	Wetland B	B
514	77	77	77	77	Sand Dune B	B
515	98	98	98	98	paved B	B
601	85	75	72	71	Residential B/C	B
602	92	92	92	92	Commercial B/C	B
603	88	88	88	88	Industrial B/C	B
604	98	98	98	98	Road, Utilities B/C	B
605	0	0	0	0	Open Pit B/C	B
606	61	61	61	61	Outdoor Recreation B/C	B
607	77	77	77	77	Cropland B/C	B
608	66	66	66	66	Orchards B/C	B
609	69	69	69	69	Permanent Pasture B/C	B
610	71	71	71	71	Shrubland B/C	C
611	73	73	73	73	Central Hardwood, Pine B/C	C
612	100	100	100	100	Lake, Pond B/C	C
613	78	78	78	78	Wetland B/C	C
614	85	85	85	85	Sand Dune B/C	C
615	98	98	98	98	paved B/C	B
701	85	75	72	71	Residential B/D	B
702	92	92	92	92	Commercial B/D	B
703	88	88	88	88	Industrial B/D	B
704	98	98	98	98	Road, Utilities B/D	B

Ccode	1/8acre	1/4acre	1/3acre	1/2acre	Land use description	Soil"
705	0	0	0	0	Open Pit B/D	B
706	61	61	61	61	Outdoor Recreation B/D	B
707	77	77	77	77	Cropland B/D	B
708	66	66	66	66	Orchards B/D	B
709	69	69	69	69	Permanent Pasture B/D	B
710	78	78	78	78	Shrubland B/D	D
711	79	79	79	79	Central Hardwood, Pine B/D	D
712	100	100	100	100	Lake, Pond B/D	D
713	78	78	78	78	Wetland B/D	D
714	88	88	88	88	Sand Dune B/D	D
715	98	98	98	98	paved B/D	B
801	90	83	81	80	Residential C	C
802	94	94	94	94	Commercial C	C
803	91	91	91	91	Industrial C	C
804	98	98	98	98	Road, Utilities C	C
805	0	0	0	0	Open Pit C	C
806	74	74	74	74	Outdoor Recreation C	C
807	84	84	84	84	Cropland C	C
808	77	77	77	77	Orchards C	C
809	79	79	79	79	Permanent Pasture C	C
810	71	71	71	71	Shrubland C	C
811	73	73	73	73	Central Hardwood, Pine C	C
812	100	100	100	100	Lake, Pond C	C
813	78	78	78	78	Wetland C	C
814	85	85	85	85	Sand Dune C	C
815	98	98	98	98	paved C	C
901	90	83	81	80	Residential C/D	C
902	94	94	94	94	Commercial C/D	C
903	91	91	91	91	Industrial C/D	C
904	98	98	98	98	Road, Utilities C/D	C
905	0	0	0	0	Open Pit C/D	C
906	74	74	74	74	Outdoor Recreation C/D	C
907	84	84	84	84	Cropland C/D	C
908	77	77	77	77	Orchards C/D	C
909	79	79	79	79	Permanent Pasture C/D	C
910	78	78	78	78	Shrubland C/D	D
911	79	79	79	79	Central Hardwood, Pine C/D	D
912	100	100	100	100	Lake, Pond C/D	D
913	78	78	78	78	Wetland C/D	D
914	88	88	88	88	Sand Dune C/D	D
915	98	98	98	98	paved C/D	C
1001	92	87	86	85	Residential D	D
1002	95	95	95	95	Commercial D	D
1003	93	93	93	93	Industrial D	D
1004	98	98	98	98	Road, Utilities D	D
1005	0	0	0	0	Open Pit D	D
1006	80	80	80	80	Outdoor Recreation D	D
1007	88	88	88	88	Cropland D	D

Ccode	1/8acre	1/4acre	1/3acre	1/2acre	Land use description	Soil"
1008	83	83	83	83	Orchards D	D
1009	84	84	84	84	Permanent Pasture D	D
1010	78	78	78	78	Shrubland D	D
1011	79	79	79	79	Central Hardwood, Pine D	D
1012	100	100	100	100	Lake, Pond D	D
1013	78	78	78	78	Wetland D	D
1014	88	88	88	88	Sand Dune D	D
1015	98	98	98	98	paved D	D
1401	100	100	100	100	Water	W
1402	100	100	100	100	Water	W
1403	100	100	100	100	Water	W
1404	100	100	100	100	Water	W
1405	100	100	100	100	Water	W
1406	100	100	100	100	Water	W
1407	100	100	100	100	Water	W
1408	100	100	100	100	Water	W
1409	100	100	100	100	Water	W
1410	100	100	100	100	Water	W
1411	100	100	100	100	Water	W
1412	100	100	100	100	Water	W
1413	100	100	100	100	Water	W
1414	100	100	100	100	Water	W
1415	100	100	100	100	Water	W
1416	100	100	100	100	Water	W